Claim Amendments

Please cancel claims 1, 2, 18, 19, 24 and 26, and amend claims 3, 4, 6, 8, 15, 20-23, 25 and 27-30 as follows:

1. (canceled) ~~A method for motion estimation in coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said method comprising:~~

~~selecting at least one reference frame for a given original video frame;~~

~~partitioning said original video frame into rectangular blocks of coefficients;~~

~~forming at least one reference block of coefficients from an offset of the rectangular blocks;~~

~~computing the differences between said at least one reference block and the rectangular blocks; and~~

~~optimizing the offset.~~

2. (canceled) ~~The method of claim 1, wherein said selecting comprises:~~

~~obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.~~

3. (currently amended) The method of claim [[2]] <u>4</u>, wherein said forming comprises:

for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, obtaining M additional rectangular blocks of coefficients for providing M reference blocks, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.

4. (currently amended) ~~The method of claim 3 wherein said computing comprises:~~ <u>A method, comprising:</u>

selecting M reference frames for a given original video frame from a video sequence having a plurality of video frames, each frame containing a plurality of coefficients, wherein M is a positive integer greater than 1;

partitioning said original video frame into rectangular blocks of coefficients; and from each of the M reference frames:

forming at least one reference block of coefficients from an offset of the rectangular blocks; and

obtaining a block difference at least partially based on a summation of absolute values of differences between corresponding individual coefficients in ~~for each of said M reference blocks, obtaining the difference between~~ in each of said rectangular ~~block~~ blocks of coefficients and ~~each~~ said at least one reference block of coefficients ~~for providing a block difference at least partially involving summation of the differences between corresponding individual coefficients in each block~~; and

optimizing the offset at least partially based on the block difference.

5. (original) The method of claim 4, wherein said optimizing comprises:

for each of said rectangular blocks of coefficients, determining an optimal horizontal offset X and vertical offset Y, wherein said determining is based at least partially on minimizing a weighted sum of M block differences.

6. (currently amended) The method of claim [[2]] 4, wherein each of the M video frames selected as the M reference frames is computed based on the same frame of original video.

7. (original) The method of claim 4, wherein the block differences for the M reference blocks are combined for providing a weighted sum having a plurality of weighting factors, and wherein each weighting factor in the weighted sum is determined at least partially based upon a quantizer parameter or the index of the reference frame subjected to that weight.

8. (currently amended) The method of claim [[2]] 4, wherein each of the M video frames selected as the M reference frames is computed by decoding the same frame of original video at a variety of quality settings.

9. (original) The method of claim 5, wherein motion is represented by a motion vector to be encoded in bits, and wherein said determining is also based on the number of bits needed to encode the motion vector.

10. (original) The method of claim 5, wherein the set of M reference frames is divided into N sub-sets, such that each of the M reference frames belongs to precisely one of the N sub-sets, and wherein the process of determining the optimal horizontal offset X and vertical offset Y is repeated for each of said N sub-sets of reference frames, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

11. (original) The method of claim 5, wherein said determining of the optimal horizontal offset X and optimal vertical offset Y involves a discrimination against offsets with large magnitudes.

12. (original) The method of claim 11, wherein the discrimination is at least partially dependent upon an index corresponding to which of the M reference frames is being considered.

13. (original) The method of claim 10, where the number N may vary from one frame of video to another frame of video.

14. (original) The method of claim 11, where the number N may vary from one frame of video to another frame of video, and the determination of the number N involves analysis of block differences in the previous frame.

15. (currently amended) The method of claim [[3]] <u>4</u>, wherein for each rectangular block, the set of M reference blocks is divided into N sub-sets, such that each of the M reference blocks belongs to precisely one of the N sub-sets, and wherein the process of determining the optimal horizontal offset X and vertical offset Y is repeated for each of said N sub-sets of

reference blocks, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

16. (original) The method of claim 15, wherein the number N of sub-sets may vary from one block to another within the given frame of video, said variation either based upon explicit signaling in the encoded bit stream or upon a deterministic algorithm.

17. (original) The method of claim 16, wherein the size of a rectangular block in one of the N sub-sets is computed at least partially using the size of a rectangular block in another of the N sub-sets or the values of the horizontal offsets X and vertical offsets Y.

18. (canceled) ~~A coding device for coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said device comprising:~~

~~a motion estimation module, responsive to an input signal indicative of an original frame in the video sequence, for providing a set of predictions so as to allow a prediction module to form a predicted image; and~~

~~a combining module, responsive to the input signal and the predicted image, for providing residuals for encoding, wherein the motion estimation block comprises a mechanism for carrying out the steps of:~~

~~selecting at least one reference frame for a given original video frame;~~

~~partitioning said original video frame into rectangular blocks of coefficients;~~

~~forming at least one reference block of coefficients from an offset of the rectangular blocks;~~

~~computing the differences between said at least one reference block and the rectangular blocks; and~~

~~optimizing the offset.~~

19. (canceled) ~~The device of claim 18, wherein the step of selecting comprises the step of:~~

~~obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.~~

20. (currently amended) The device of claim [[19]] 21, wherein ~~the step of~~ said forming comprises ~~the step of~~:

obtaining M additional rectangular blocks of coefficients for providing M reference blocks, for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.

21. (currently amended) ~~The device of claim 20, wherein the step of computing comprises the step of:~~ An encoder, comprising:

a motion estimation module, responsive to an input signal indicative of an original frame in a video sequence, for providing a set of predictions so as to allow a prediction module to form a predicted image, wherein the video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame; and

a combining module, responsive to the input signal and the predicted image, for providing residuals for encoding, wherein the motion estimation block is configured for

selecting M reference frames for a given original video frame in said plurality of video frames, wherein M is a positive integer greater than 1;

partitioning said original video frame into rectangular blocks of coefficients; and from each of the M reference frames:

forming at least one reference block of coefficients from an offset of the rectangular blocks; and

obtaining a block difference at least partially based on a summation of absolute values of differences between corresponding individual coefficients in ~~for each of said M reference blocks, the difference between~~ in each of said rectangular ~~block~~ blocks of coefficients and ~~each~~ said at least one reference block of coefficients ~~for providing a block~~

~~difference at least partially involving summation of the differences between corresponding individual coefficients in each block~~; and

optimizing the offset at least partially based on the block difference.

22. (currently amended) The device of claim 21, wherein ~~the step of~~ said optimizing comprises ~~the step of~~:

determining, for each of said rectangular blocks of coefficients, an optimal horizontal offset X and vertical offset Y, wherein said determining is based at least partially on minimizing a weighted sum of M block differences.

23. (currently amended) A computer readable medium having embedded therein a software program ~~for use in motion estimation in coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame~~, said software program comprising~~:~~

~~a code for selecting at least one reference frame for a given original video frame;~~

~~a code for partitioning said original video frame into rectangular blocks of coefficients;~~

~~a code for forming at least one reference block of coefficients from an offset of the rectangular blocks;~~

~~a code for computing the differences between said at least one reference block and the rectangular blocks; and~~

~~a code for optimizing the offset~~ programming codes for carrying out the method according to claim 4.

24. (canceled) ~~The software program of claim 23, wherein the code for selecting said at least one reference frame comprises:~~

~~a code for obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one~~.

25. (currently amended) The ~~software program~~ computer readable medium of claim [[24]] 23, wherein said ~~the code for~~ forming ~~said at least one reference block~~ comprises:

a code for obtaining M additional rectangular blocks of coefficients for providing M reference blocks, for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.

26. (canceled) ~~The software program of claim 25, wherein the code for computing the differences comprises:~~

~~a code for obtaining, for each of said M reference blocks, the difference between said rectangular block and each said reference block of coefficients for providing a block difference at least partially involving summation of the differences between corresponding individual coefficients in each block~~.

27. (currently amended) The ~~software program~~ computer readable medium of claim [[26]] 25, wherein said ~~the code for~~ optimizing ~~the offset~~ comprises:

~~a code for~~ determining, for each of said rectangular blocks of coefficients, an optimal horizontal offset X and vertical offset Y, wherein the determination is based at least partially on minimizing a weighted sum of M block differences.

28. (currently amended) The ~~software program~~ computer readable medium of claim [[26]] 23, ~~further comprising~~

~~a code for combining~~ wherein the block differences for the M reference blocks are combined for providing a weighted sum having a plurality of weighting factors, and wherein each weighting factor in the weighted sum is determined at least partially based upon a quantizer parameter or the index of the reference frame subjected to that weight.

29. (currently amended) The ~~software program~~ computer readable medium of claim [[27]] 23, wherein the set of M reference frames is divided into N non-overlapping subsets, and wherein the code for determining the optimal horizontal offset X and vertical offset Y repeats

the process for each of said N sub-sets of reference frames, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

30. (currently amended) The ~~software program~~ <u>computer readable medium</u> of claim 25, wherein for each rectangular block, the set of M reference blocks is divided into N non-overlapping sub-sets, and wherein the code for determining the optimal horizontal offset X and vertical offset Y repeats the process for each of said N sub-sets of reference blocks, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.